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Printed: 02/11/2002

Document Title New Insights on the Effectiveness of Prenatal Care

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Document Date 31-Jul-96

Document Description: This study examines methodological approaches to estimating the role of prenatal care on newborn health. It empirically tests the impact of prenatal services in reducing newborn costs associated with delivery and postnatal care. It found the marginal effects of this care are small, a modified version of

Project Specifics

SR Number 95-223

Project Number 30-P-90538/2

Project Title The Demand for Prenatal Care and its Impact on Birth Weight and Neonatal Costs Among Low Income Women, With Controls for Self-Selection

Awardee City University of New York, The Graduate School and University Center of New York

Project Officer Hackerman, Carl

Principle Investigator

Funding Level 21330

Start Date 01/23/1995

End Date 04/22/1996

Project Description: Expansions of Medicaid eligibility for pregnant women are based on the assumption that prenatal care is efficient in reducing the incidence of low birth weight. This study used a new index of adequacy of prenatal care as a starting point in assessing the

Initiated (CMS): sgalloway 	Date: 11-Feb-02	→	Accepted (IQ):	Date:
Released (IQ):	Date:	→	Received (Sub):	Date:
Finished (Sub):	Date:	→	QC'd (IQ):	Date:
Returned (IQ):	Date:	→	pproved (CMS):	Date:

NEW INSIGHTS ON THE EFFECTIVENESS OF PRENATAL CARE

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HCFA Grant No. 30-P-90538/2

July 1996

The statements contained in this report are solely those of the author and do not necessarily reflect the views or policies of the Health Care Financing Administration. The grantee assumes the responsibility for the accuracy and completeness of the information contained in this report.

ACKNOWLEDGEMENTS

I want to thank Michael Grossman, Theodore Joyce, Robert Kaestner and Linda Edwards for helpful comments and their overriding concern for my economics education.

CONTENTS

Executive Summary	1
Introduction	2
Background	3
A. Trends in infant mortality	3
B. Causes of low birth weight	3
C. Empirical Evidence	4
Data and Methods	6
A. Data	6
B. Theoretical framework	7
C. Empirical implementation	9
Results	9
A. Sample statistics	9
B. Adequacy of prenatal care	10
C. OLS estimates	11
D. Two-stage estimates	12
E. Estimated benefits and costs	12
F. Bounding OLS estimates	13
Discussion	14
References	16
Tables	
Table 1 - Means and proportions	21
Table 2 - Rates of low birth weight	24
Table 3 - Means by level of care	25
Table 4 - OLS estimates of infant costs	26
Table 5 - OLS estimates including LOS	28
Table 6 - Specification changes	31
Table 7 - OLS and 2SLS estimates	32
Table 8 - Sample-selection estimates	33
Table 1A - Distribution of births, whites	34
Table 2A - Distribution of births, blacks	35
Table 3A - Distribution of births, Hispanics	36
Table 4A - Rates of low birth weight, whites	37
Table 5A - Rates of low birth weight	38
Table 6A - Rates of low birth weight	39

Executive Summary

This study examines methodological approaches to estimating the role of prenatal care on newborn health and empirically tests the impact of prenatal services in reducing newborn costs associated with delivery and postnatal care. The sample consists of low income women predominantly covered by Medicaid. Vital statistic records are merged with hospital discharge abstracts for over 47,000 singleton births delivered at public hospitals in New York City from 1990 to 1992.

The main findings of the study are:

- The marginal effects of prenatal care are small, especially for women who receive some prenatal services. The costs of providing additional prenatal care exceed the savings resulting from improved birth outcomes. These results are consistent across all races and age groups.
- A modified version of the Kotelchuck index (Kotelchuck, 1994a,b) is a better measure of adequacy of care than the commonly used IOM/Kessner index (IOM, 1973). Distinguishing women who abstain from care and those who receive more than a recommend number of visits underscores the role of selection in the decision to seek care. The IOM/Kessner index inappropriately combines distinct levels of care, obscuring large differences in birth outcomes.
- The large, positive effects of care found in previous multivariate analyses are likely to be biased by omitted variables, inappropriate measures of prenatal care and poor instruments. For instance, including more precise measures of illicit drug use lowers the impact of abstaining from care more than twofold.
- The consistency of two-stage estimation techniques such as instrumental variables (IV) and sample-selection models rests on the validity of identification restrictions. Instrumenting prenatal care use with supply and health area measures yields imprecise and implausibly large effects of care. There is simply no clinical or biological evidence to support effects of this magnitude.
- Government health policies aimed at improving birth outcomes have focused on expanding access to prenatal care. The results suggest that future policies should address other known risk factors and direct greater attention to understanding the causes of preterm delivery.

The confluence of potential biases makes it extremely difficult to estimate the impact of prenatal care with secondary data. Although a large body of empirical work supports the value of early and frequent prenatal care, data limitations, methodological shortcomings and the pervasive role of selection cast doubt on the validity of those findings.

I. Introduction

The consequences of low birth weight are potentially severe. Infants weighing less than 2500 grams at birth are nearly 40 times more likely to die in the neonatal period than normal weight infants and they incur costs 2 to 10 times higher (Schwartz, 1985; Boyle et al, 1983). Moreover, low weight infants are more likely to experience childhood health problems, delayed cognitive development, lower educational attainment and reduced lifetime earnings (Grossman & Edwards, 1979), and there is little clinical evidence that neonatal technologies which enhance survival, moderate long term health effects. The costs of low birth weight are so high that relatively inexpensive preventive measures such as prenatal care seemingly pay for themselves.

A large body of empirical evidence generally confirms this view. Research on the effectiveness of prenatal care follows two strategies. The first evaluates programs offering enhanced prenatal services. While many of the programs find positive effects for specific subgroups, the overall impact of care is less consistent than in studies based on vital statistic records (OTA, 1988). Multivariate analyses using birth certificate data find overwhelming evidence that prenatal medical care improves newborn health. In a review of the literature, the Office of Technology Assessment (OTA, 1988) found prenatal care had a positive and significant impact on birth weight in 18 of 21 multivariate studies, and a negative and significant effect on neonatal mortality in 11 of 15 analyses. Furthermore, 5 additional studies using instrumental variable techniques to control for the potential endogeneity of prenatal care found even larger effects.

Although there is a "weight of evidence" in support of early and frequent prenatal visits, it is extremely difficult to separate the true effects of care from other factors correlated with both the decision to seek care and newborn health. Researchers have long suspected that the decision to seek care is related to the health of the pregnancy. Mothers with poor health endowments or those experiencing a problematic pregnancy are more likely to seek early care, biasing coefficients downward. On the other hand, women who abstain from care may act in measured and unmeasured ways that raise the likelihood of an adverse birth outcome, biasing coefficients in the opposite direction. The net effect of these and other potential biases is uncertain.

In this paper, I focus on methodological approaches to estimating the effects of prenatal care and empirically test the impact of care on infant costs for a relatively homogenous sample of urban women predominantly covered by Medicaid. Unlike previous work, this study does not purport to have definitive estimates. Rather, I attempt to bound prenatal care coefficients given the likelihood and direction of selection bias. The findings suggest the marginal benefits of care are small, especially for women who receive some prenatal services. Consequently, public health policies which target alternative risk factors may yield larger improvements in birth outcomes.

The remainder of the paper proceeds as follows. In Section II, I summarize previous work in both the medical and economics literature. Section III outlines the data and the empirical strategy. Results are presented in Section IV and their implications are discussed in Section V.

II. Background

A. Trends in infant mortality, low birth weight and prenatal care use

The correlation between infant mortality and low birth weight is well established. In New York City between 1976 and 1978, nearly three-fourths of neonatal deaths in white infants and over 83 percent of those in black infants occurred in babies weighing less than 2500 grams or born prior to 37 weeks of gestation (Paneth, 1995). Infant mortality rates in the U.S. fell roughly 4 percent per year from 1965-1985 due largely to improved neonatal technologies, wider access to prenatal care and reductions in maternal smoking during pregnancy. Infant mortality has continued to fall since 1985, but at a much slower rate. In fact, almost all of the reduction in infant deaths over the past decade is due to improved neonatal care.

Trends in low birth weight have followed a similar pattern, declining steadily from 1965 to 1984 and trending upward over the past decade. The percentage of low birth weight births reached an all time low in 1984 for both races - 5.6 percent for whites and 12.4 percent for blacks. Since that time, rates have increased slightly for whites and more significantly among blacks. The white rate of low birth weight rose to 5.64 percent in 1988 and up to 5.8 percent by 1991. Meanwhile, the black rate increased to 12.97 percent in 1988 and reached 13.6 percent by 1991 (NCHS, 1990,1993).

Trends in low birth weight and prenatal care use are less consistent. The rise in low birth after 1984 roughly coincided with increases in the percentage of women abstaining from care. Between 1980-1988, the percentage of women delaying care until the last trimester or not at all rose over 15 percent for whites and more than 25 percent for blacks. However, on the other hand, the percentage of women receiving first trimester care rose slightly over the same period.

B. Causes of low birth weight and the impact of prenatal care

Low birth weight is primarily a function of two factors - slow intrauterine growth and preterm delivery. The effects of the latter dominate. The majority of low birth weight infants are born prematurely and nearly all infants weighing less than 1500 grams are born before the 37th week. Prenatal care can potentially prolong gestation if physicians are able to detect pregnancy complications and take steps which reduce the severity or likelihood of a preterm birth. Unfortunately, the etiology of prematurity is largely unknown and recent evidence suggests that prenatal medical care is unlikely to affect the vast majority of early deliveries (Paneth, 1995). In a study of predominantly poor black women, Tucker et al.(1991) found less than a quarter of preterm births were theoretically preventable and the vast majority of these cases could not have been avoided given early identification and existing treatment strategies.

Unlike prematurity, the principal causes of slow intrauterine growth are more clearly established. Low prepregnancy weight, poor nutrition and weight gain, and maternal behaviors such as smoking, drinking and illicit drug use have been widely shown to retard fetal growth. However, with the exception of maternal weight gain, there is little evidence that prenatal care dramatically affects the remaining risk factors. Poor prepregnancy health is largely beyond the scope of most prenatal care protocols, especially for low income women receiving care at public hospitals and clinics. Moreover, the percentage of women who quit smoking and using illicit drugs

upon pregnancy is relatively low. Smoking during pregnancy is associated with reductions in birth weight of 150-250 grams on average and roughly 25 percent of women smokers quit upon learning they are pregnant. However, nearly one-third relapse before delivery and minorities and those who lack a regular provider are far less likely to receive physician advice regarding smoking cessation and alcohol use (Kogan, 1994). Consequently, quit rates may be largely independent of prenatal care use within certain populations. Data on the cessation of drug use during pregnancy are far less reliable, yet the limited success of more comprehensive drug treatment programs suggests that routine prenatal care does not dramatically alter maternal substance abuse, especially among the heaviest users.

C. Empirical evidence on the effectiveness of prenatal care

Medical and public health literature

The impact of prenatal care on birth outcomes is one of the most widely studied topics in infant health. The Institute of Medicine (IOM, 1985, 1988) and the Office of Technology Assessment (OTA, 1988) provide valuable reviews of the medical and public health literature. Analyses based on vital statistic records measure the impact of care on large, heterogeneous populations, and consistently report positive and significant correlations between prenatal care use and birth weight. However, these studies typically lack information on medical risk factors and adverse maternal behaviors that may be correlated with the demand for prenatal care. A second limitation of these analyses is that adequacy of prenatal care is typically measured by some version of the IOM/Kessner index (IOM, 1973). Yet, the Kessner index is dominated by month of initiation and fails to distinguish two important groups - mothers who abstain from care and those receiving more than a recommended number of visits (Kotelchuck, 1994a,b). As shown in Section IV, this is likely to bias parameter estimates by aggregating women with vastly different outcomes and observed characteristics.

Empirical finding from programs offering more comprehensive prenatal services may also be biased since participants are not randomly assigned to control and experimental groups. More motivated women or those at greater risk are more likely to enroll in programs offering enhanced services and the net effect of this selection is unclear. In addition, findings from these studies are difficult to generalize because program enhancements and target populations vary widely.

Benefit-cost analyses of prenatal care suffer similar shortcomings. In a review of the literature, Huntington & Connell (1994) find the majority of the studies rely on non-comparable control groups or simply ignore the potential effects of selection in the decision to seek care. Moreover, costs and cost savings are often based on assumptions regarding the effectiveness of care rather than derived from actual billing data. For instance, Schwartz (1989) calculates cost savings from shifting the distribution of birth weight to the right. Similarly, the IOM estimates savings from lowering the rate of low birth weight from 11.5 percent to 10 and 9 percent, but does not discuss the feasibility of the proposed reductions (IOM, 1985). Despite the importance of this issue and its policy significance, the cost-effectiveness of prenatal care has not been demonstrated in a methodologically sound analysis

Economic literature

Economic research in infant health has focused on the endogeneity of inputs. The decision to seek prenatal care, smoke cigarettes or engage in risky behaviors are seen as choices variables and thus are endogenous to the birth outcome. Work by Rosenzweig & Schultz (1982, 1983, 1988), Grossman & Joyce (1990)¹ and Joyce (1994) model the production of infant health in two stages. Endogenous inputs are predicted in the first stage by a set of instruments, and the predicted values are included in the second stage birth weight equation. The results vary across studies, but generally find OLS underestimates the gains to care for specific groups. In other words, adverse selection is the dominant form of bias. Women at greater risk of experiencing an adverse birth outcome attempt to offset poor health endowments by seeking more prenatal care. This spurious association between intense utilization of prenatal services and poor birth outcomes biases downward the coefficients on care.

Although these models make important contributions to modeling infant health production functions, the empirical findings they generate are inconsistent with clinical and biological evidence. For instance, Rosenzweig and Schultz find 2SLS estimates of prenatal care delay are roughly 40 times larger than OLS coefficients. Delaying care 5 months lowers mean birth weight by 260 grams on average, or 8 percent. Moreover, they find that care works primarily by extending gestation. This result is surprising in that there is no clinical or biological evidence to support effects of this magnitude, raising concerns regarding the validity of the instruments. Price proxies and aggregate geographic measures explain only a small percentage of the variation in the endogenous variables. Moreover, the instruments may be correlated with the error term in the birth weight equation. For example, Rosenzweig and Schultz (1982, 1983) exclude maternal education from the birth weight equation, presuming it affects newborn health only through its impact on prenatal care. However, in the New York City sample, women with less than 12 years of schooling are nearly twice as likely to use illicit drugs as those with some college education. Since Rosenzweig and Schultz (1982, 1983) do not control for maternal drug use, education may be correlated with the disturbance term in the second stage. In fact, there is growing evidence that the consistency of two-stage estimates requires exceptionally good instruments. Even a weak correlation between the instruments and the error term can lead to larger biases than if one ignores endogeneity altogether and uses OLS (Bound et al., 1995; Nelson & Startz, 1990).

To circumvent problems associated with individual heterogeneity, Frank et al. (1992) estimate a fixed-effects model with aggregate panel data of U.S. counties to examine the impact of prenatal care on the incidence of low birth weight. Aggregate data eliminates heterogeneity bias provided women with similar health endowments do not cluster geographically. They find the initiation of prenatal care is significant for both blacks and whites, yet the effect is small in absolute terms. Raising black rates of first trimester care to that of whites (a 24 percent increase) would reduce the rate of low birth weight for blacks by only 2.4 percent. Moreover, they find coefficients on prenatal care fall dramatically for blacks (in absolute value) and rise for whites when fixed effects are removed. They interpret this as evidence of adverse selection among blacks and favorable or positive selection among whites. In other words, black women with relatively poor health endowments are more likely to initiate care in the first trimester, whereas white women with better than average endowments are more likely to seek early and frequent care.

¹ Grossman & Joyce (1990) estimate a 3 equation model that also examines selection in the resolution of pregnancies.

III. Data and Methods

A. Data

The data consist of 47,291 singleton births to mothers who delivered at any of 11 public hospitals in New York City from 1990-1992. More than 90 percent of infant costs are covered by Medicaid. Creation of the study sample involved matching infant cost data from the Health and Hospital Corporation (HHC) to vital statistic records from the New York City Department of Health. The New York City birth certificate is one of the most detailed in the country. Besides variables in the U.S. standard certificate, it contains a confidential portion with questions regarding illicit substance abuse, by type of drug, as well as alcohol consumption and smoking levels during pregnancy. The NYC certificate has information on financial coverage, categorized by Medicaid, health maintenance organization (HMO), self-pay and other third party. There is an indicator of enrollment in the Supplemental Nutrition Program for Women, Infant and Children (WIC) as well as maternal occupation and work status during pregnancy. Drug measures on the birth certificate are supplemented by ICD-9 classifications for substance abuse. Any indication of illicit drug use based on maternal self-report, chart review or a positive urine toxicology screen is included. Empirical specifications include dummy variables for cocaine, heroin and other drugs. This is an important distinction from previous analyses in that illicit drug use is likely to be correlated with the demand for care.

The dependent variable is the natural log of total infant costs associated with delivery and postnatal care. Costs are calculated for each infant based on their diagnostic related group (DRG). There are 39 possible DRG's for neonates in New York State. Costs are calculated for each infant based on 55 percent of statewide average costs for a particular DRG and 45 percent of hospital specific costs in the base year (1981). Infant costs for uninsured and private pay patients are estimated using hospital-specific average costs for Medicaid patients by DRG and year. Year and hospital dummies are included in all empirical specifications to control for variations over time and facility.

Area specific measures are used to predict prenatal care in two-stage models. Instruments include neighborhood characteristics such as number of homicides, syphilis cases and drug related deaths per capita, as well as local area labor market measures of employment and poverty. I also include two dichotomous indicators of the availability of prenatal care providers. One distinguishes providers that are reimbursed under New York State's Prenatal Care Assistance Program (PCAP). The other identifies non-PCAP prenatal care providers. PCAP providers offer enhanced services and are authorized to make decisions regarding presumptive eligibility. Nearly 75 percent of Medicaid clients in New York City received care at PCAP facilities in 1992. The criteria for becoming a PCAP provider is based on a facility's capacity to provide a range of services rather than area-specific health measures and thus provides an uncontaminated means of assessing the effectiveness of more comprehensive services.

Adequacy of prenatal care is based on a modified version of the Kotelchuck index (Kotelchuck, 1994a,b). The index categorizes care on two dimensions -- timing of initiation and utilization of care conditional on first visit and gestation. The two scales are combined into a 4 category index that classifies care as inadequate, intermediate, adequate and adequate-plus. We modify the index slightly by adding a fifth category of care for women who abstain from care.

Distinguishing women who obtain no prenatal services as well as those who receive more than the recommended number of prenatal visits separates women with vastly different birth outcomes and observed characteristics. These distinctions have a significant impact on parameter estimates and highlight the role of selection across different levels of care.

B. Theoretical framework

Household production theory provides a convenient framework for analyzing the impact of market and non-market inputs on the production of infant health. In a simple 2-good model, parents maximize a joint utility function which consists of their own consumption and the health of their expected child. Decisions regarding infant health occur in two stages: parents choose levels of prenatal inputs and the physician or hospital decision-maker determines the use of neonatal inputs conditional on infant health at delivery. Newborn health at delivery is a function of prenatal inputs such as medical care, tobacco and illicit drugs, whereas infant health at discharge depends on the stock of health at birth and subsequent utilization of neonatal inputs.

More formally, let infant health at discharge (H) be a function of prenatal (PI) and neonatal inputs (NI), as well as a random disturbance term (e_i).

$$(1) H_i = (PI, NI, e_i)$$

In addition, let birth weight (B) be a function of prenatal inputs such as prenatal care (M), a vector of other inputs such as tobacco and illicit drugs that directly determine infant health (Z), and a vector of demographic and obstetrical characteristics including maternal race, age and parity that also impact on the birth outcome (W).

$$(2) B_i = (PI, e_2)$$

$$(2') B_i = (M, Z, W, e_2)$$

Infant health at discharge is measured by total infant costs (C_i) associated with delivery and postnatal care. Infant costs at discharge depend on the stock of health at birth (B) and utilization of resources between delivery and discharge. Letting hospital length of stay (L) be a proxy neonatal inputs and substituting for PI and NI yields an infant cost equation (3) which depends on neonatal inputs and hospital length of stay.

$$(3) C_i = (M, Z, W, L, e_3)$$

Length of stay can be substituted out of equation (3), yielding an infant cost equation which depends solely on neonatal inputs (4).

$$(4) C_i = (M, Z, W, e_4)$$

The coefficients on prenatal care in equation (3) represent the direct effects of prenatal care on infant costs holding neonatal inputs constant. In contrast, estimates of M from equation (4) measure the total effects of care operating directly or indirectly through birth weight.

Ordinary least-squares (OLS) will yield biased estimates of the parameters in equations (3) and (4) if the demand for health inputs such as prenatal care are correlated with unmeasured or unobserved factors that also affect newborn health. There is some evidence that the demand for prenatal care is inversely related to the health of the fetus (Harris, 1982; Rosenzweig & Schultz, 1982, 1983, 1988; Grossman & Joyce, 1990; Joyce, 1994). Put differently, $\text{Cov}(M, e_i)$ and $\text{Cov}(B, e_i) \neq 0$. In fact, the correlation between prenatal care use and the error term can take many forms, leading to a confluence of potential biases. Three types of biases have been cited in the literature which may *underestimate* the gains to care.

1. Adverse selection: mothers with poor health endowments or those who anticipate a complicated pregnancy seek more prenatal care.
2. Favorable endowments: marginal benefits of care decline as the health endowment improves, i.e. women with better than average health endowments or those who experience uneventful pregnancies have less incentive to seek care.
3. Fetal Selection: as a cohort of pregnancies progresses, less healthy fetuses are more likely to be terminated. Thus, women who initiate care in the last trimester are less likely to experience complications simply because the fetus has survived into the seventh month (Harris, 1982).

Selection bias may work in the opposite direction as well. Two commonly cited biases that may *overestimate* the gains to care are:

4. Favorable Selection: receipt of prenatal care reflects parental attitudes and behaviors towards the pregnancy. Women who follow an ideal prenatal care schedule may have better diets, less stress, or act in unmeasured ways which contribute to better birth outcomes.
5. Preterm Delivery Bias: women who deliver prematurely have fewer opportunities to receive prenatal services. Inadequate care may be a result rather than a cause of preterm births.

Attempts to control for selection have taken three approaches². The first and most common is to increase the number of covariates or to decrease heterogeneity by analyzing relatively

² The third approach relies on more natural experiments in which an exogenous intervention, such as expansions in Medicaid eligibility, increases the utilization of prenatal care. We briefly discuss the expansions in Section V.

homogenous samples (). The aim is to proxy or hold constant hard to measure factors such as nutrition, motivation, and adverse behaviors. A second approach is to apply instrumental variable techniques (IV) or sample selection methodologies in order to control for the reverse causality between the expectation of an adverse birth outcome and utilization of care (). Two stage methodologies typically yield larger coefficients on care than OLS, yet the consistency of the parameter estimates depends on the validity of the instruments. As discussed in Section IV, finding valid instruments is extremely difficult.

C. Empirical implementation

The empirical strategy is to regress infant costs as specified in equation (4) on a basic set of exogenous regressors and prenatal care. I then add a set of additional covariates that include health insurance, maternal age, parity and a vector of risk factors to assess the impact of observed factors on infant costs. I also estimate equation (3) to control for the effects of neonatal inputs. Thus, we can compare the direct and total effects of prenatal care on infant costs, and assess the role of observed factors on costs associated with delivery and postnatal care.

Given the likely role of unobservables, I then estimate cost equations by 2SLS and sample selection models treating prenatal care as endogenous. To estimate care, I use a simple probit when the dependent variable is dichotomous (care vs. no care) and an ordered probit estimated by maximum likelihood for polychotomous measures such as a modified Kotelchuck index. I then assess the relative impact of observed and unobserved factors and attempt to bound the parameter estimates given the likely direction of selection bias.

IV. Results

A. Sample statistics

Sample means are presented in Table 1. There are large variations in risk factors across racial groups. Reported smoking among blacks is nearly 3 times the rate of Hispanics and 50 percent higher than whites. Black rates of illicit drug use are also high. Nearly 8 percent admit or test positive for heroin and 6 percent for cocaine. Rates for whites and Hispanics are considerably lower, ranging from 2 to 4 percent, yet are still above national averages³. More than 6 out of 10 births are to foreign born women, ranging from 75 percent of Hispanics to 43 percent of blacks. Two-thirds of deliveries are to single mothers and nearly 90 percent of costs are paid by Medicaid. Blacks and Hispanics are more likely to live in a health area that has a prenatal care provider, yet those same neighborhoods are characterized by higher crime rates and greater incidence of poverty.

There are some peculiarities of the data that merit attention. First, we omit mother's prepregnancy weight and weight gain during pregnancy because they are not recorded in nearly

³ In a study of nearly 30,000 pregnant women in California, 7.8 percent of blacks tested positive for cocaine and 2.5 percent for opiates. White and Hispanic rates ranged from 0.5 to 1.5 percent of urine toxicologies (Vega et al, 1993). We expect slightly higher incidence of drug use due to the low SES of the sample.

half of all cases. To test the importance of their exclusion, we run separate analyses on the subset of observations that include these measures⁴. Second, insurance status is not measured consistently across data sources. Just over 11 percent of blacks and Hispanics and 22 percent of whites are uninsured based on vital statistic records. Yet, among those, more than half are covered by Medicaid according to hospital discharge abstracts. The differential may reflect the financial incentives of the hospitals to enroll uninsured, Medicaid-eligible women in order to receive compensation. In all empirical specifications, we use vital statistic measures of insurance coverage since it more accurately reflects the mother's knowledge of her insurance status and thus the price of prenatal care.

B. Adequacy of prenatal care

Rates of low birth weight by timing and utilization of care are presented in Table 2. More than 51 percent of women in the sample receive inadequate care while just over 10 percent are classified as adequate-plus. Corresponding figures from the 1980 National Natality Survey are 16.8 and 18 percent, respectively. Rates of low birth weight follow a U-shaped pattern. Women who receive adequate-plus or no prenatal care experience exceptionally high rates of low birth weight, while birth outcomes of women receiving inadequate, intermediate or adequate care vary little. For example, those who initiate care in the first 4 months of pregnancy and receive more than the expected number of visits (adequate-plus care) experience rates of low birth weight in excess of almost other groups (20.0 and 17.6 per 100 live births). Whereas women who initiate care at the same time yet receive 80-109 percent of recommended visits have rates of low birth weight of 8.1 and 6.4 percent, respectively. In contrast, there is little variation in rates of low birth weight among those receiving between 50 and 109 percent of recommended visits regardless of month of initiation. Race specific figures (Tables 1A-3A in appendix) follow similar patterns, although absolute rates are significantly higher among blacks.

Over 90 percent of women in the upper left cell of Table 2 receive no prenatal services and experience rates of low birth weight two to three times higher than women in adjacent cells. The importance of this distinction is illustrated in Table 3, which compares selected means across three indices of care. There is considerably less variation in birth outcomes across categories of the Kessner index (Panel C). Newborn costs for infants with late care are roughly \$1100. higher than for those who receive adequate care, and average stays are only two days longer. In comparison, the five category Kotelchuck index (Panel A) reveals considerably larger differences in all measures of newborn health. Infants with no care have hospital stays 5.5 days longer than those who receive adequate care and incur costs two and a half times higher. The Kessner index inappropriately combines distinct levels of care, obscuring dramatic differences in birth outcomes.

⁴ Mother's prepregnancy weight and weight gain during pregnancy (nutritional intake) are considered important determinants of fetal growth.

C. OLS estimates

OLS estimates of infant costs are presented in Tables 4 and 5 by race and ethnicity. Odd-numbered columns include prenatal care and a basic set of exogenous regressors. Even-numbered columns add a range of demographic and personal characteristics. The coefficients on prenatal care are consistent with unadjusted means. Infant costs are significantly higher for women who abstain from care relative to those receiving adequate services, as well as for women who receive the most intense utilization (adequate-plus)⁵. This pattern persists across race and ethnicity, although the coefficients are considerably larger and more significant for blacks. In contrast, infant costs associated with inadequate or intermediate care are not significantly different from those receiving adequate care.

High infant costs and extended stays associated with adequate-plus care provide some evidence of adverse selection. Women who receive adequate-plus care have followed an ideal prenatal care schedule and their poor birth outcomes primarily reflect bad health endowments. Failure to control for this selection would reveal a spurious negative association between prenatal care use and newborn health.

To test the sensitivity of prenatal care coefficients to specification changes, we exclude measures of illicit drugs. Most studies using vital statistic records omit drug use measures since they are based on maternal self-reports and grossly underestimate actual prevalence. The impact of this exclusion is dramatic (Table 6). Coefficients on no care rise two-to-threefold when maternal drug use is omitted, regardless of race. Note that since illicit drug use is concentrated among women who receive insufficient prenatal services, the coefficients on adequate-plus and intermediate care are unaffected.

To test the robustness of the parameter estimates to different indices of care, I substitute the IOM/Kessner index for the modified Kotelchuck index in measuring adequacy of prenatal services. The Kessner index classifies care as late, intermediate or adequate, with the latter category used as the reference group. The results are strikingly different. Infant costs are roughly constant across categories and are actually lowest for women receiving intermediate care. Aggregating adequate-plus and adequate care women as well as failing to distinguish between inadequate and no care obscures significant differences in prenatal care use and birth outcomes.

With regards to the other coefficients, there is some evidence that foreign born women have better birth outcomes after controlling for observed differences. There are large variations in unadjusted means between the two groups. Native mothers are 6 times more likely to smoke and over ten times more likely to use illicit drugs during pregnancy. Furthermore, more than 8 out of 10 births to native mothers are out-of-wedlock. In light of these figures, it is not surprising that average infant stays are nearly 3 days longer and infant costs are over 75 percent higher for native-born women. However, these deficits are largely eliminated in multivariate analyses. Infant costs of foreign born mothers are 4 to 10 percent lower after controlling for observed risk factors, and remain negative and significant even after controlling for length of stay. Similarly, racial differences decline but remain significantly different from zero. Mean infant costs are 72 percent

⁵ The coefficients in Table 4 are not precisely marginal effects. Since prenatal care measures (X) are dichotomous, the percentage change in Ln costs (Y) is given by $e^{\beta-1}$. For instance, a coefficient of .27 would reflect a 31.0 percent change in infant costs.

higher for blacks than whites. Yet, the gap falls to 8 percent after controlling for observed differences.

Finally, infant cost equations are estimated on two subsamples. The first excludes observations without measures of prepregnancy weight and weight gain during pregnancy. These variables are important determinants of fetal growth yet are missing in nearly half of all cases. The results are generally insensitive to their inclusion except for the coefficient on no care. Abstaining from care has a bigger impact on infant costs within this subsample. A second specification test excludes observations in which health insurance status differs between data sources. In this case, the effect of no care falls by 6 percentage points while other coefficients are largely unchanged.

D. Two-stage estimates

Given the likely role of unobservables, I endogenize prenatal care and estimate cost and stay equations by 2SLS. The prenatal care equation is identified by availability measures and area characteristics. Neighborhood effects are measured by the number of homicides, drug related deaths and syphilis cases in the health area. Labor force participation and local area poverty rates proxy for socioeconomic status. The availability of prenatal care is captured by the number of PCAP and non-PCAP providers in the health area.

First stage results explain 12 to 17 percent of the variation in the demand for care. However, second stage estimates are relatively imprecise and unrealistically large⁶. The results suggest that abstaining from care raises infant costs nearly threefold for blacks and by 180 percent for all women in the sample relative to receipt of some prenatal services (Table 7). However, the coefficients are only significant for blacks due to large standard errors.

There is growing evidence that instruments that explain a small percentage of the variation in the endogenous variable can lead to large inconsistencies in IV estimates even if there is only a weak correlation between the instruments and the disturbance term in the structural equation (Bound et al, 1995; Nelson & Startz, 1990). The implausibly large results from endogenizing care suggest the instruments are not orthogonal to the error term. Alternatively, I estimate two-stage selection models to control for the reverse causality between prenatal care and infant costs. An ordered probit is used in the first stage to predict the five levels of care in the modified Kotelchuck index. The estimated parameters are used to construct a correction factor(s), which is inserted in the cost equation as a separate regressor(s). The results are similar to 2SLS estimates. Abstaining from care raises infant costs 172 percent in a pooled sample of whites, blacks and Hispanics. There is simply no clinical evidence to support effects of this magnitude.

E. Estimated benefits and costs

Infant costs and cost savings associated with increased levels of care are used to calculate benefit-cost ratios. The majority of women in the sample receive prenatal care at HHC clinics, which are designated PCAP providers. The hospitals are compensated for each prenatal visit

⁶ F-statistic on the 7 pure instruments is 3.84, significantly larger than the critical $F_{7,\infty,.95} = 2.01$. The dependent variable is dichotomous (no care=1).

according to the Medicaid reimbursement schedule, all inclusive Parts A and B. From April 1990 through March 1991, Medicaid reimbursed PCAP providers \$214.27 for an initial prenatal visit, and \$113.38 for each follow-up visit. Reimbursement rates rose approximately 6 percent per year between April 1990 and April 1992, and 1.6 percent from April 1992-April 1993. To compute the costs of providing care for each level of the index, we multiply per visit reimbursement fees by the average number of race-specific visits for each category of care. For instance, blacks with adequate-plus care receive 12.84 visits on average. Using average reimbursement rates over the 3 year period, the hospital would receive \$1623. for providing services, or \$264. more than then for the provision of adequate prenatal care.

Since two-stage estimates are generally insignificant, cost savings associated with greater levels of care are based on OLS parameter estimates from Table 4. To calculate savings, the coefficient on care is multiplied by average infant costs for each level of care. For example, white women who abstain from care incur 11 percent higher infant costs than those who receive adequate prenatal services. Average infant costs for mothers who receive adequate prenatal care equal \$2467, thus the cost savings associated with adequate versus no prenatal care are approximately \$271. ($.11 * \$2467$).

Benefit-cost ratios are less than 1.00 in all cases largely due to the magnitude of OLS coefficients. The ratio of savings to costs from moving women who receive no care to adequate ranges from .13 for Hispanics to .70 for blacks. Movement between other levels of care yield similar results, as do separate analyses for teens and adults. The ratios are considerably below previous estimates partly because cost savings are confined to the delivery and postnatal period. However, the weak causal relationship between prenatal care use and birth outcomes suggests that estimates based on long term cost savings would not dramatically alter these findings.

F. Bounding OLS estimates

In light of the inability to specify a fully endogenous model, it is instructive to examine whether OLS estimates are likely to over- or understate the gains to care. To do this, I assess the likelihood and direction of selection bias for each level of care. For instance, coefficients on adequate-plus may be biased downward due to adverse selection and biased upward as a result of favorable selection⁷. We find ample evidence of the former. Adequate-plus women initiate care early and receive more than the recommended number of visits, yet nearly 60 percent deliver infants weighing less than 2500 grams. Although favorable selection may bias parameter estimates in the opposite direction, consistently positive coefficients on adequate-plus care indicate that adverse selection is the dominant form of bias.

Women who receive inadequate or intermediate care either delay initiation before seeking care or fail to receive a recommend number of subsequent visits. Women who experience healthy pregnancies are less likely to seek additional visits, all else constant. Moreover, women who delay initiation until the last trimester are less likely to experience complications simply because the fetus has survived into the seventh month. Both biases potentially underestimate the costs associated with inadequate or intermediate care.

⁷ The other three biases listed in Section III are generally not applicable to women receiving adequate-plus care.

Finally, coefficients on no care are most likely to be affected by preterm delivery bias and favorable selection. Receipt of no care may be indicative of other maternal behaviors detrimental to the health of the fetus. Furthermore, a lack of care may be a result rather than a cause of preterm delivery. In either case, the direction of the bias is upward, causing OLS estimates to potentially overstate the costs associated with no prenatal care⁸.

V. Discussion

By the mid-1980's, there was widespread belief that prenatal care was a cost-effective means of improving newborn health. A large body of empirical evidence supported this view and led to recent expansions in Medicaid eligibility for poor and near-poor pregnant women. The logic was straight forward - lowering the cost of care would increase the demand for prenatal services, reducing the incidence of low birth weight and infant mortality. Although the percentage of births covered by Medicaid rose from 14 percent in 1985 to 32 percent by 1991, initial assessments of the expansions reveal modest increases in prenatal care use and small to insignificant improvements in newborn health (Braveman et al., 1993; Haas et al., 1993; Piper et al., 1990, 1994; Currie & Gruber, 1993). Disappointing results from a natural experiment uncontaminated by selection bias casts doubt on positive findings from previous studies based on non-experimental data.

The decision to seek care is a choice variable, often related to a woman's reproductive history and the health of her current pregnancy. Consequently, prenatal care and other health inputs are potentially endogenous. Lacking valid instruments, I attempt to circumvent this problem by controlling for a wide set of known determinants and estimating the impact of care on a relatively homogenous group of high-risk women. Furthermore, I form bounded estimates of the effectiveness of care given the likely direction of selection bias. Three results stand out. First, in contrast with the majority of previous work, the marginal effects of prenatal care are small. This result is partly due to the inclusion of illicit drug measures. Maternal substance abuse is highly correlated with insufficient prenatal care and is likely to capture the effects of other unobservables detrimental to the health of the fetus. Secondly, a modified version of the Kotelchuck index is a richer measure of adequacy of care. The choice of index significantly affects empirical estimates and leads to vastly different conclusions in shaping public health policies. Thirdly, two-stage estimates, however appropriate, are only as good as their instruments. Poor instruments typically yield implausibly large coefficients which add little to policy debates aimed at improving newborn health.

The confluence of potential biases make it extremely difficult to estimate the true impact of care, and my attempt to bound these estimates are merely suggestive. In any case, they do not alter the basic policy implications of the study. Women who receive adequate-plus care are largely beyond the scope of government health policies. Thus, coefficients on adequate-plus care have little bearing on policy debates. Similarly, the extent to which OLS may understate costs associated with inadequate or intermediate care is bounded by the relatively small coefficients on no care. Cost differentials associated with no prenatal care range from 5 to 15 percent and represent upper bound estimates.

⁸There is no evidence to suggest that women abstain from care due to favorable endowments.

The importance of proper medical attention in complicated pregnancies cannot be understated, yet this study suggests that policies which address other known risk factors may yield larger benefits. Prenatal care providers should be linked to expanded smoking cessation programs and drug treatment facilities, and much greater emphasis should be placed on promoting prepregnancy health. Maternal health deficits and poor health habits cannot be overcome by routine prenatal visits over a 6-9 month period. Government health policies over the past two decades have focused on improving access to care, in part, because it is relatively inexpensive and easy to implement. In contrast, improving prepregnancy health and moderating detrimental behaviors are more complex problems that necessitate greater political and public support. Future research should address the causes of preterm births and ways to identify women at high risk.

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Table 1

Means and Proportions of Selected Variables

Variables	All (N=47,291)	Whites (N=3036)	Blacks (N=18,817)	Hispanics (N=24,151)
Birth outcomes				
Infant costs	3673	2748	4735	2996
Length of stay (LOS)	5.95	5.08	7.22	5.11
Birth weight	3198	3300	3111	3261
Very low BW (500-1499g)	0.02	0.01	0.03	0.01
Moderately low BW (1500-2499g)	0.09	0.06	0.12	0.07
Adequacy of timing index				
Initial prenatal visit, months 1-2	0.18	0.12	0.18	0.18
Initial prenatal visit, months 3-4	0.35	0.32	0.34	0.37
Initial prenatal visit, months 5-6	0.21	0.20	0.22	0.21
Initial prenatal visit, months 7-9 or no care	0.26	0.36	0.26	0.24
Adequacy of utilization index				
110% or more of expected visits	0.24	0.23	0.27	0.22
80-109% of expected visits	0.32	0.29	0.30	0.33
50-79% of expected visits	0.24	0.22	0.22	0.27
0-49% of expected visits	0.20	0.26	0.20	0.19
Combined Kotelchuck index				
Adequate-plus prenatal care	0.11	0.09	0.13	0.10
Adequate prenatal care	0.21	0.18	0.20	0.22
Intermediate prenatal care	0.16	0.13	0.14	0.18
Inadequate prenatal care	0.39	0.42	0.40	0.38
No prenatal care	0.13	0.19	0.13	0.12
Exposures				
Smoking	0.09	0.09	0.15	0.05

Cocaine	0.03	0.03	0.06	0.02
Heroin	0.05	0.04	0.08	0.03
Other drugs	0.01	0.01	0.01	0.01
Sexually transmitted diseases (STD)	0.02	0.02	0.02	0.02

Obstetrical measures

Prepregnancy weight (log)	4.94	4.94	4.98	4.92
Prepregnancy weight unknown	0.44	0.53	0.36	0.51
Weight gain during pregnancy (log)	3.28	3.29	3.28	3.29
Weight gain unknown	0.46	0.54	0.39	0.53
First birth (1=yes)	0.37	0.44	0.34	0.38
Parity ≥ 4	0.13	0.09	0.18	0.11
WIC	0.52	0.41	0.55	0.52
Sex (1=male)	0.51	0.51	0.51	0.51
Previous fetal loss (1=yes)	0.01	0.01	0.02	0.01
C-section	0.17	0.14	0.16	0.18
Foreign born (1=yes)	0.61	0.53	0.42	0.75
Mother's age	25.6	25.8	25.8	25.4
Mother's age squared	693.6	697.7	704.9	678.8
Mother works during pregnancy	0.10	0.07	0.14	0.08

Mother's schooling

Mother's educ., 8th grade or less	0.13	0.10	0.05	0.19
Mother's educ., grades 9-11	0.32	0.23	0.35	0.32
Mother's educ., completed high school	0.42	0.48	0.45	0.38
Mother's educ., 1-3 years college	0.09	0.09	0.11	0.08
Mother's educ., completed college or more	0.03	0.06	0.02	0.02
Mother's education unknown	0.02	0.04	0.02	0.01

Father's schooling

Father's educ., 8th grade or less	0.08	0.05	0.02	0.13
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Father's educ., grades 9-11	0.15	0.13	0.10	0.20
Father's educ., completed high school	0.28	0.35	0.24	0.29
Father's educ., 1-3 years college	0.05	0.07	0.05	0.05
Father's educ., completed college or more	0.03	0.06	0.03	0.02
Father's education unknown	0.41	0.34	0.57	0.31
Out-of-wedlock (1=yes)	0.68	0.50	0.77	0.65
Method of Payor				
Medicaid (Birth Certificate/HHC)	0.78/0.89	0.68/0.85	0.80/0.87	0.81/0.91
Uninsured	0.14/0.06	0.23/0.10	0.11/0.06	0.13/0.05
HMO	0.01/0.01	0.01/0.01	0.01/0.01	0.01/0.01
Other private insurance	0.05/0.05	0.08/0.05	0.05/0.07	0.04/0.04
Payor unknown	0.02/0.00	0.01/0.00	0.03/0.00	0.01/0.00
Local Area Characteristics				
Non-PCAP prenatal clinic in health area (HA)	0.37	0.23	0.44	0.34
PCAP Provider (HA)	0.24	0.14	0.27	0.24
Drug dependent deaths/1000 pop (HA)	0.38	0.23	0.41	0.37
Homicides/1000 pop (HA)	0.88	0.44	1.01	0.84
Syphilis cases/1000 pop (HA)	6.07	3.02	7.95	5.11
Percent poor in census tract (CT)	19.85	16.81	19.40	20.86
Labor force participation rate (CT)	61.77	61.76	61.97	61.49

Table 2

Rates of low birth weight by two factors of Kotelchuck prenatal care index for pooled sample of blacks, whites and Hispanics, New York City, 1990-1992 (N=47,291)

Month Prenatal Care Began	Received Services				Total
	0-49%	50-79%	80-109%	110%+	
7-9 or none	19.9	6.2	8.0	7.3	14.0
5-6	9.4	6.5	6.2	12.1	8.7
3-4	9.5	5.3	6.4	17.6	8.6
1-2	9.3	6.8	8.1	20.0	10.2
Total	16.7	6.0	6.9	13.9	10.3

Table 3

Selected means by level of care using the Kotelchuck index with four and five categories and the Kessner Index, from a pooled sample of blacks, whites, and Hispanics in New York City, 1990-1992.

Panel A: Five Category Kotelchuck Index

	<u>Adequate Plus</u>	<u>Adequate</u>	<u>Intermediate</u>	<u>Inadequate</u>	<u>No Care</u>
Mean costs	5839	2805	2604	2984	6793
Mean LOS	7.7	4.7	4.6	5.3	10.2
Mean birth weight	3043	3274	3300	3231	2967

Panel B: Four Category Kotelchuck Index

	<u>Adequate Plus</u>	<u>Adequate</u>	<u>Intermediate</u>	<u>Inadequate</u>
Mean costs	5839	2805	2604	3984
Mean LOS	7.7	4.7	4.6	6.6
Mean birth weight	3043	3274	3300	3163

Panel C: Kessner Index

	<u>Adequate</u>	<u>Intermediate</u>	<u>Late</u>
Mean costs	2905	3324	3998
Mean LOS	4.9	5.3	6.9
Mean birth weight	3267	3236	3128

Table 4

OLS estimates of infant costs by race and ethnicity in New York City, 1990-1992.
(absolute t-statistics in parentheses)

Variable	<u>Blacks</u>		<u>Hispanics</u>		<u>Whites</u>	
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	7.55 (289.32)	6.88 (61.19)	7.45 (438.17)	7.15 (91.49)	7.55 (77.29)	7.19 (28.62)
Sex	-0.02 (1.89)	-0.03 (2.43)	0.02 (2.30)	0.02 (2.52)	0.00 (0.13)	0.00 (0.15)
<u>Level of Care</u>						
Adequate Plus	0.28 (11.94)	0.27 (12.66)	0.19 (11.05)	0.13 (11.33)	0.22 (4.08)	0.20 (4.10)
Adequate ^a	---	---	---	---	---	---
Intermediate	-0.03 (1.43)	-0.04 (1.85)	-0.02 (1.45)	-0.02 (1.65)	-0.00 (0.09)	-0.02 (0.42)
Inadequate	0.05 (2.82)	-0.01 (0.35)	0.03 (2.22)	0.01 (0.50)	-0.03 (0.86)	-0.06 (1.61)
No prenatal care	0.64 (26.71)	0.26 (11.30)	0.21 (12.75)	0.07 (4.43)	0.25 (5.55)	0.11 (2.55)
<u>Maternal characteristics</u>						
Foreign born	-0.26 (18.18)	-0.10 (6.98)	-0.15 (13.32)	-0.04 (3.91)	-0.20 (8.22)	-0.07 (2.41)
C-section	0.43 (24.11)	0.42 (25.82)	0.33 (28.07)	0.33 (29.91)	0.60 (17.36)	0.40 (11.12)
Out-of-wedlock		-0.00 (0.23)		0.02 (1.94)		-0.02 (0.57)
Mother's age		0.02 (2.98)		-0.01 (1.82)		-0.01 (0.33)
Mother's age squared		-0.00 (2.28)		0.00 (2.76)		0.00 (0.51)
First birth		0.06 (4.01)		0.06 (5.72)		0.07 (2.49)
Parity >= 4		0.03 (1.57)		0.03 (1.99)		-0.06 (1.30)
WIC		-0.05 (3.62)		0.01 (0.97)		0.01 (0.30)
Previous fetal loss		0.14 (2.96)		0.04 (0.98)		-0.01 (0.11)

Insurance Status

Medicaid	0.15 (7.58)	0.22 (15.95)	0.21 (6.25)
Other third party	-0.09 (2.96)	-0.03 (1.09)	0.04 (0.70)
HMO	-0.13 (2.09)	-0.07 (1.58)	0.01 (0.04)
Finance unknown	0.03 (0.65)	-0.01 (0.27)	0.15 (1.39)

Exposures

Smoking	0.09 (4.87)	0.09 (4.34)	-0.01 (0.22)
Other drugs	0.20 (3.36)	0.21 (3.50)	0.22 (1.60)
Heroin	1.18 (47.18)	1.37 (48.44)	1.26 (18.15)
Cocaine	0.50 (17.23)	0.37 (10.20)	0.45 (5.46)
Sexually Transmitted Diseases (STD)	0.19 (4.72)	0.20 (6.19)	0.25 (2.46)

Maternal Education

12 Years schooling	-0.04 (3.02)	-0.02 (1.58)	-0.05 (1.71)
13+ Years Schooling	-0.04 (2.11)	-0.03 (1.85)	-0.08 (1.92)
Education Unknown	-0.05 (1.00)	0.04 (0.99)	0.01 (0.13)

Paternal Education

12 Years Schooling	-0.04 (1.80)	-0.01 (1.28)	-0.02 (0.49)
13+ Years Schooling	-0.02 (0.85)	0.01 (0.76)	0.00 (0.03)
Education Unknown	0.02 (1.01)	0.03 (2.69)	0.05 (1.20)

Year & Hospital Dummies	yes	yes	yes	yes	yes	yes
Number of Observations	18817	18817	24151	24151	3036	3036
Adjusted R-square	.138	.301	.124	.265	.141	.276

* Reference category

Table 5

OLS estimates of infant costs including hospital length of stay.
By race and ethnicity in New York City, 1990-1992. (absolute t-statistics in parentheses)

Variable	<u>Blacks</u>		<u>Hispanics</u>		<u>Whites</u>	
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	7.18 (430.78)	6.66 (61.19)	6.97 (588.76)	6.70 (120.09)	6.93 (104.72)	6.84 (38.43)
Sex	-0.01 (1.56)	-0.02 (2.29)	0.01 (1.00)	0.01 (1.01)	0.01 (0.38)	0.00 (0.13)
LOS	0.07 (154.71)	0.07 (139.98)	0.10 (141.64)	0.10 (125.11)	0.10 (52.26)	0.09 (45.78)
Squared LOS	-0.00 (70.81)	-0.00 (64.06)	-0.00 (68.91)	-0.00 (62.90)	-0.00 (23.58)	-0.00 (20.97)
<u>Level of Care</u>						
Adequate Plus	0.08 (5.38)	0.09 (6.59)	0.07 (6.01)	0.07 (5.99)	0.11 (2.91)	0.10 (2.77)
Adequate*	---	---	---	---	---	---
Intermediate	-0.04 (2.65)	-0.03 (2.51)	-0.01 (1.42)	-0.01 (1.19)	-0.02 (0.66)	-0.02 (0.53)
Inadequate	-0.01 (0.46)	-0.01 (1.13)	-0.02 (2.86)	-0.01 (1.79)	-0.06 (2.26)	-0.05 (1.88)
No prenatal care	0.08 (4.85)	0.01 (0.40)	-0.04 (3.28)	-0.01 (1.33)	-0.03 (1.10)	-0.01 (0.43)
<u>Maternal characteristics</u>						
Foreign born	-0.10 (11.18)	-0.05 (4.81)	-0.03 (3.94)	-0.01 (1.19)	-0.04 (2.27)	-0.02 (1.20)
C-section	0.13 (11.17)	0.15 (13.33)	0.04 (4.69)	0.05 (6.06)	0.12 (4.40)	0.12 (4.71)
Out-of-wedlock		0.01 (0.82)		0.01 (1.67)		-0.03 (1.25)
Mother's age		0.02 (3.19)		-0.00 (0.70)		-0.01 (1.13)
Mother's age squared		-0.00 (2.50)		0.00 (1.19)		0.00 (1.39)
First birth		0.05 (5.32)		0.03 (5.01)		0.05 (2.69)
Parity >= 4		-0.01 (0.71)		-0.02 (1.71)		-0.01 (0.18)
WIC		0.01 (0.74)		0.04 (4.98)		0.04 (2.00)

Previous fetal loss	0.01 (0.48)	0.04 (1.25)	-0.04 (0.43)			
<u>Insurance Status</u>						
Medicaid	0.19 (15.23)	0.26 (26.22)	0.22 (9.36)			
Other third party	-0.06 (2.94)	0.00 (0.19)	0.05 (1.20)			
HMO	-0.11 (2.57)	0.00 (0.18)	0.01 (0.09)			
Finance unknown	0.00 (0.13)	0.02 (0.92)	0.11 (1.41)			
<u>Exposures</u>						
Smoking	0.03 (1.94)	0.04 (2.94)	0.00 (0.13)			
Other drugs	0.05 (1.29)	0.10 (2.29)	0.25 (2.52)			
Heroin	0.62 (36.08)	0.29 (13.39)	0.27 (5.13)			
Cocaine	0.03 (1.31)	-0.01 (0.43)	0.11 (1.83)			
Sexually Transmitted Diseases (STD)	0.11 (4.03)	0.07 (3.06)	0.14 (1.95)			
<u>Maternal Education</u>						
12 Years schooling	-0.02 (2.67)	-0.00 (0.12)	-0.03 (1.21)			
13+ Years Schooling	-0.04 (2.80)	-0.02 (1.75)	-0.02 (0.61)			
Education Unknown	0.02 (0.65)	0.06 (2.37)	0.09 (1.83)			
<u>Paternal Education</u>						
12 Years Schooling	-0.02 (1.45)	-0.01 (1.40)	-0.02 (0.88)			
13+ Years Schooling	-0.00 (0.07)	0.01 (0.67)	0.01 (0.33)			
Education Unknown	0.00 (0.21)	-0.01 (0.90)	-0.00 (0.11)			
Year & Hospital Dummies	yes	yes	yes	yes	yes	yes
Number of Observations	18817	18817	24151	24151	3036	3036

Adjusted R-square	.655	.691	.605	.627	.616	.637
* Reference category						

Table 7

Ordinary least squares (OLS) and 2SLS estimates of infant costs with a dichotomous measure of prenatal care, by race and ethnicity¹

	OLS	2SLS
No Care - All women	0.14 (12.70)	1.03 (3.20)
No Care - Whites	0.13 (3.80)	0.05 (0.12)
No Care - Blacks	0.24 (12.16)	1.37 (2.66)
No Care - Hispanics	0.06 (4.21)	0.75 (1.62)

¹ Dichotomous measure of prenatal care (No Care = 1)

Table 8

Coefficients on prenatal care in infant cost specifications controlling for self-selection into level of care (absolute t-statistics in parentheses)

	Uncorrected for selection*	Single correction term	Correction term interacted with level of care
	(1)	(2)	(3)
Adequate Plus	0.22 (18.18)	0.09 (1.48)	0.04 (0.34)
Adequate	---	---	---
Intermediate	-0.02 (2.43)	0.05 (1.35)	0.15 (3.26)
Inadequate	-0.00 (0.48)	0.18 (2.04)	0.35 (3.32)
No care	0.15 (12.00)	0.51 (2.98)	1.00 (4.36)
Lambda		0.13 (2.09)	---
Lambda ₄			0.37 (3.72)
Lambda ₃			0.23 (2.89)
Lambda ₂			0.19 (2.72)
Lambda ₁			0.27 (3.69)
Lambda ₀			0.23 (2.45)
Adj. R ²	.288	.288	.288

* Results from Table 4

Table 1A

Distribution of births by two factors of Kotelchuck prenatal care index for sample of whites, New York City, 1990-1992. (N=3,036)

Month Prenatal Care Began	Received Services				Total
	0-49%	50-79%	80-109%	110%+	
7-9 or none	20.7	4.0	4.7	6.9	36.2
5-6	1.7	4.8	6.9	6.9	20.2
3-4	2.8	9.2	12.8	6.7	31.5
1-2	1.3	3.9	4.7	2.2	12.1
Total	26.4	21.8	29.1	22.7	100.0

Table 2A

Distribution of births by two factors of Kotelchuck prenatal care index for sample of blacks, New York City, 1990-1992 (N=18,817)

Month Prenatal Care Began	Received Services				Total
	0-49%	50-79%	80-109%	110%+	
7-9 or none	14.3	3.2	3.6	5.2	26.2
5-6	1.6	4.6	6.5	9.5	22.1
3-4	2.7	8.9	14.0	8.2	33.7
1-2	1.9	5.2	6.4	4.4	18.0
Total	20.5	21.8	30.4	27.3	100.0

Table 3A

Distribution of births by two factors of Kotelchuck prenatal care index for sample of Hispanics, New York City, 1990-1992. (N=24,151)

Month Prenatal Care Began	Received Services				Total
	0-49%	50-79%	80-109%	110%+	
7-9 or none	13.0	3.0	3.7	4.6	24.3
5-6	1.5	5.5	6.8	7.0	20.7
3-4	2.7	11.6	15.6	6.7	36.6
1-2	1.9	6.6	6.6	3.2	18.4
Total	19.2	26.7	32.6	21.5	100.0

Table 4A

Rates of low birth weight by two factors of Kotelchuck prenatal care index for sample of whites, New York City, 1990-1992. (N=3,036)

Month Prenatal Care Began	Received Services				Total
	0-49%	50-79%	80-109%	110%+	
7-9 or none	11.3	3.3	1.4	4.8	7.9
5-6	3.9	2.1	2.9	6.3	3.9
3-4	4.8	4.3	3.6	14.7	6.3
1-2	5.3	6.8	6.9	19.4	9.0
Total	9.9	4.1	3.6	9.6	6.7

Table 5A

Rates of low birth weight by two factors of Kotelchuck prenatal care index for sample of blacks, New York City, 1990-1992. (N=18,817)

Month Prenatal Care Began	Received Services				Total
	0-49%	50-79%	80-109%	110%+	
7-9 or none	29.4	8.1	12.2	8.3	20.3
5-6	12.0	8.9	8.9	14.4	11.5
3-4	13.0	7.2	8.1	21.9	11.6
1-2	12.4	11.0	10.2	22.8	13.8
Total	24.3	8.6	9.2	16.9	14.3

Table 6A

Rates of low birth weight by two factors of Kotelchuck prenatal care index for sample of Hispanics, New York City, 1990-1992. (N=24,151)

Month Preantatal Care Began	Received Services				Total
	0-49%	50-79%	80-109%	110%+	
7-9 or none	13.5	5.0	6.2	6.7	10.1
5-6	8.3	5.3	4.6	10.2	6.9
3-4	7.4	4.3	5.4	13.5	6.7
1-2	7.3	4.5	6.6	16.7	7.7
Total	11.6	4.6	5.6	11.5	7.7

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